2013

METR 323: Physical Meteorology—A Peer Review of Teaching Project Benchmark Portfolio

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Course Portfolio

METR 323 – Physical Meteorology

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Executive Summary

The portfolio documents the method that I used for teaching METR 323 - "Physical Meteorology" in Spring 2013. The method is designed to improve the students' learning through hands-on activities, and to adjust the teaching plan based upon the assessment of the student learning. Hands-on out-door activities are added into the course; statistical analysis and anonymous survey are conducted to benchmark the improvement in students' learning. Results show that hands-on activities not only increase the student's interest and understanding in the course materials, but also improve the overall students' satisfaction for the course. By documenting the results and activities throughout the course, I am able to systematically analyze and improving my teaching skills that will be helpful in my future teaching of the same course as well as other courses. It is also hoped that the portfolio will make my teaching visible to my peers and help my colleagues who might teach the similar course in the future.

Course Description

METR 323 - "Physical Meteorology" is a one-semester four-credit course required for all undergraduate majors in the Department of Earth and Atmospheric Sciences at University of Nebraska-Lincoln (UNL). In addition to normal lectures, it includes 1-credit lab as well. It is a critical course in atmospheric sciences, and most students enrolled in the class are seniors. The course essentially provides student an opportunity to learn physical fundamentals that every meteorologist/climatologist needs to know. It serves as a prerequisite course to many other 300-level and 400-level courses. In the past, this course is perceived to be very challenging and difficult, and students won't take it until in their last semester right before graduation.

The course introduces the physical processes that provide the foundation for weather forecasting and climate prediction, including radiative transfer, cloud and precipitation formation, as well as the atmospheric electricity. The course also explores the physical underpinnings of such atmospheric phenomena as optical displays (for example, rainbows, halos, etc.) and lightning. These topics are closely related to our daily lives, and also essential for the students to learn many higher-level courses particularly in the technical area of atmospheric sciences. These topics are also recommended as part of the curriculum by the National Weather Service for training meteorologists. In fact, to be hired as a civil servant by NOAA to conduct weather forecast, the student needs to show that these topics are covered by various courses in their transcripts. The prerequisite for this course include CSCE 150E (programing with Fortran), METR 205 (thermal dynamics), and PHYS 212 (general physics II). The programming course is needed, as the course will require students to apply physical principals they learned in the class to solve real problems related to atmosphere and weather. In the digital era, this means that students' answers to questions should be quantitative if all possible, and so, the lab associated with this course is designed to provide opportunity for students to develop their programming skills. The quantitative skills (such as computer programming) are essential for undergraduates majoring in atmospheric sciences. This is because the knowledge of today's weather is essential for conducting accurate forecast of tomorrow's weather. Consequently, atmospheric science is awash with observation data collected by various kinds of platforms ranging from ground stations, air planes, balloons, satellites, and buoys (over the ocean). Analyzing these observation data is highly valuable for students to get hands-on experience of atmospheric physics, and to become a good weather forecaster or atmospheric scientist.

In terms of content, the course is broadly divided into two parts drawn materials respectively from two different textbooks (see Appendix A). The first part is about radiative transfer including energy from the Sun, how solar energy is transferred in the atmosphere, and interacts with surface, how solar energy is distributed around the Earth, and how Earth is cooled through its emission of infrared energy out of the space. When describing the radiative transfer processes in the atmosphere, the roles of clouds, aerosols, and trace gases (including greenhouse gases) are also introduced, and hence particle scattering and gas absorption spectra are taught. From particle scattering theory, students will learn to explain why the sky is blue, how rainbow is formed, why CO_2 is a greenhouse gas, as well as at what conditions we can see Glory, Green storms, and Halo in the atmosphere.

The second part of the course is about clouds, especially how water droplets and ice crystals are distributed inside the clouds, the size, the number, and the life cycle of cloud droplets, as well as the processes responsible for the formation of rain, snow, and hail. At the end of the course, the concept of how atmospheric lightning is formed is also introduced.

While the topics described above are interesting, teaching the physics behind these phenomenon is challenging because: (a) radiation is something that we can not visualize it in detail; it can be felt but is not tangible for physically touching, moving, and/or detangling; (b) understanding the concept of how atmospheric particles and gases interact with radiation requires lots of imagination of the processes at the microphysical scale; (c) few observational data is collected within clouds during precipitation or storm events, and hence the theory of rain formation requires imagination as well.

Teaching Methods/Course Materials/Course Activity

The course consists of three major components: lecture in class, homework/lab assignments, mid-term and final exam. In 2013, I added out-door field activities as part of the lab assignment and conducted surveys to allow students to reflect on these out-door activities. Those newly added activities are documented and analyzed here as part of my participation in UNL's Peer-Review Teaching program.

Lecture

A major goal of this course is to deliver the fundamental knowledge and problem solving skills in atmospheric science to the students; therefore the course is almost entirely lecture based, although inquires are also frequently used throughout the lecture. I use the Blackboard system for outside classroom communication; the lecture materials are often posted one-day early before the actual class, and homework/lab assignments are posted on the day when they are distributed to the students. During the lecture, from time to time, I will ask pop-up questions to each student in a sequence according to the alphabet order of their family's names; this is to check the students' understanding and encourage them to actively participate in the classroom learning. Often, these questions are designed to be in series to develop students' critical thinking for interpreting a complicated concept or figure. Typical examples include:

- What do you find or can you see/learn from this figure/concept?
- Tell us what are the main features in this figure, and why is that?
- That student has shared his/her thoughts about why the results appear like this, do you have a different thought or you agree with that student?
- If what that student just said is correct, why/how we can see such and such in the figure or observed data?

In addition to the materials in the textbook, I often will link the course materials to many forefronts of current research in the field. I am a true believer that the beauty of science should be and can be explained by simple sentences and physical principals. Hence, by linking what students learned in the textbook to what are being actively researched in the field, the students can appreciate more of what they learned, see how the theory itself is evolving and applied in the reality, understand what are the well-known or less known areas -- all of which in turn further spark students' interest in the course.

For example, when I teach the CO_2 effect on climate, I showed two slides: one is the time series of CO_2 with most current data record (Fig. 1); one is the upward terrestrial radiation measured by NASA's satellite over Mars and Earth (Fig. 2). The first is topical, as most students already heard a lot from TV and other medias on the increasing trend of CO_2. But, how much is CO_2 in today's atmosphere? Starting with this question, I found students are immediately interested to see the first slide. The second slide also interests students because it is the data collected by satellite over Mars - something that can immediately trigger the students' curiosity. I then use this slide to point out the specific wavelengths (15 μm) that CO_2 absorbs the terrestrial radiation – students can find easily from the slide that there is a deep dip in the observed spectra. Finally, I link these two slides together, and ask students that if CO_2 acts like a blanket to absorb the radiation emitted from the Earth surface and CO_2 concentration in atmospheric continuously increases, what the temperature in atmosphere will be? Most students are engaged with this question and can have a right answer. In addition, they will also know the CO_2 amount in the atmosphere is around 400 ppm now, but can increase by 3-4 ppm next year, and CO_2 absorbs at 15 μm. Such quantitative knowledge is an essential part that makes an undergraduate student taking physical meteorology class differ from other undergraduates!

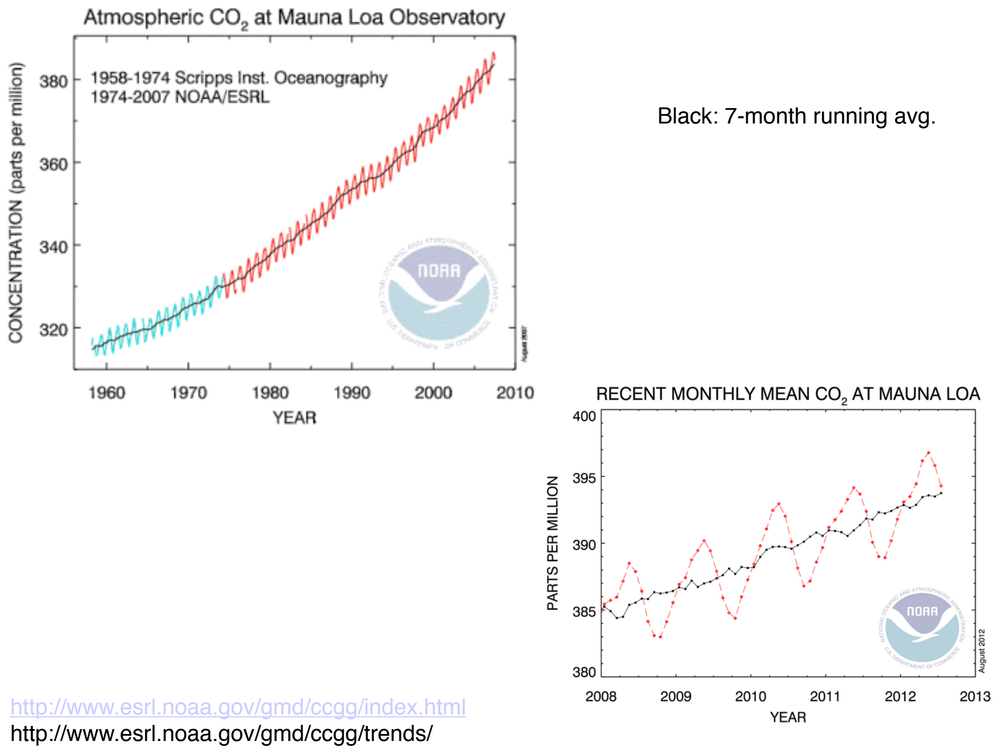


Figure 1. A slide showing the increase of CO2.

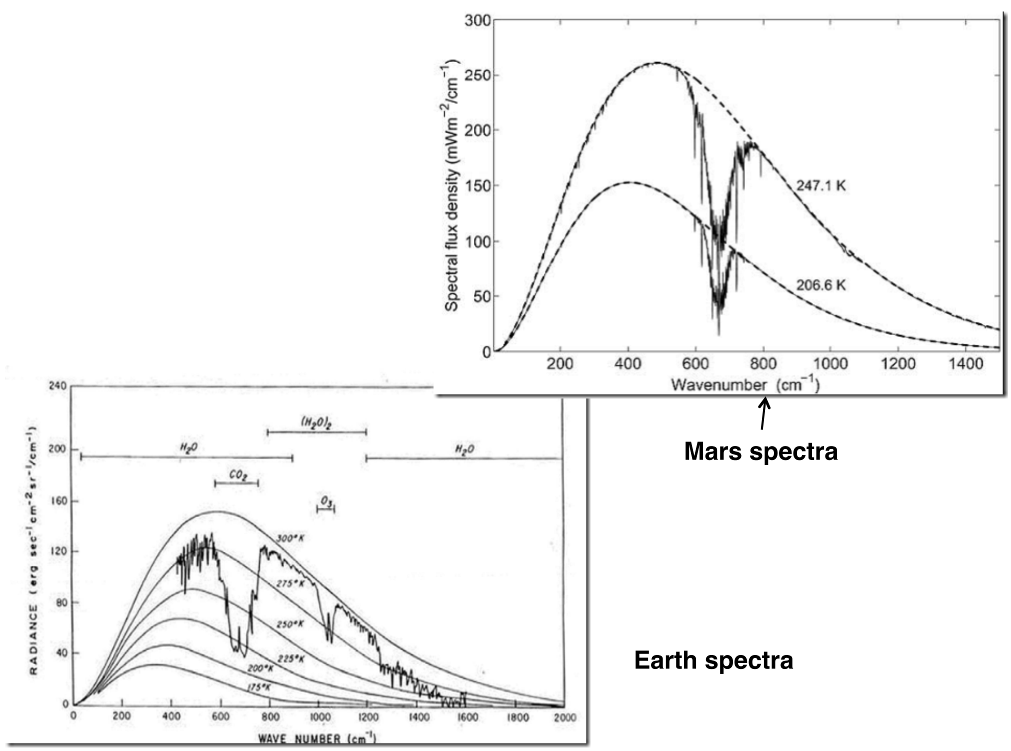


Figure 2. A slide shown the satellite-measured spectra of upward radiation over Mars and Earth.

Homework/Outdoor hands-on activities

In total, 5 homework sets are assigned to the students, and all homework are graded by a full-time Graduate Teaching Assistant who also teaches the lab. Every homework usually consists a series of problems that will take student 2-3 weeks to complete. Indeed, the later homework also builds up the previous one, and they are connected by a series of small problems that eventually lead students to develop a numerical model to estimate the amount of solar energy for any given time and location over the Earth. This numerical model is useful for planning of solar power plants, but cannot be completed by a single homework. By completing all the homework, the students are able to see the strategy to tackle a big problem with a series of small steps.

Two hands-on activities are added into the Spring 2013 assignment to strengthen the students' learning as well as their ability to solve real problems.

a) Take measurements of direct solar radiation at specific wavelengths, as well as diffuse and direct amount of solar energy at the surface (Figure 3). Through this hands-on activity, students appreciate more deeply on the concept of direct vs. diffuse radiation, as well as particle scattering in the atmosphere. They also had hands-on experience to learn Beer's law, a fundamental law for deriving the atmospheric turbidity and optical depth from direct sun measurements, as well as how direct, diffuse, and total solar energy at the surface vary with the optical depth in the atmosphere. Further, they also learned more about the concept of broadband vs. narrow band radiation, and the application of theory (such as Beer's law) to design the measurements.

b) Analyze the role of cloud and solar radiation in regulating the seasonal variation of surface temperature in Lincoln NE (Figure 4). Such analysis really brings what students learned to home. In Lincoln, the monthly mean temperature in 2001-2010 peaked in June, although the radiation from the Sun always peaks in July. The mismatch is because that the cloud fraction is higher in July than in June, so the actual solar input at the surface is maximum in June instead of July. Indeed, after considering both cloud fraction and solar radiation, the monthly variation of surface temperature can be explained by 99% (Figure 5).

Fig. 3. Hands-on activities for students to take measurements of direct and diffuse solar energy at the surface, the atmospheric optical depthand water vapor amount using Sun-photometer and Pynaromenters.

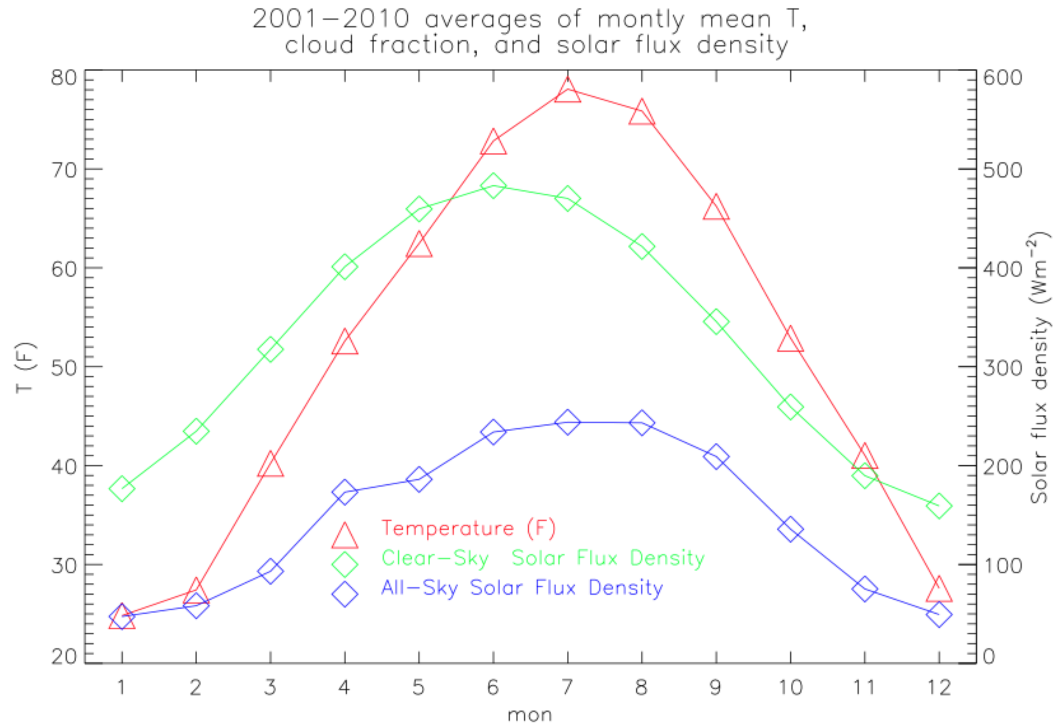


Figure 4. Monthly variation of temperature, cloud fraction and clear-sky solar flux in Lincoln, NE in 2001-2010. The Lincoln monthly mean temperature is from the reports by National Weather Service, cloud fraction data is from NASA's satellite observation, and clear-sky downward solar flux is from the numerical model developed by the student in the class through homework 1-4.

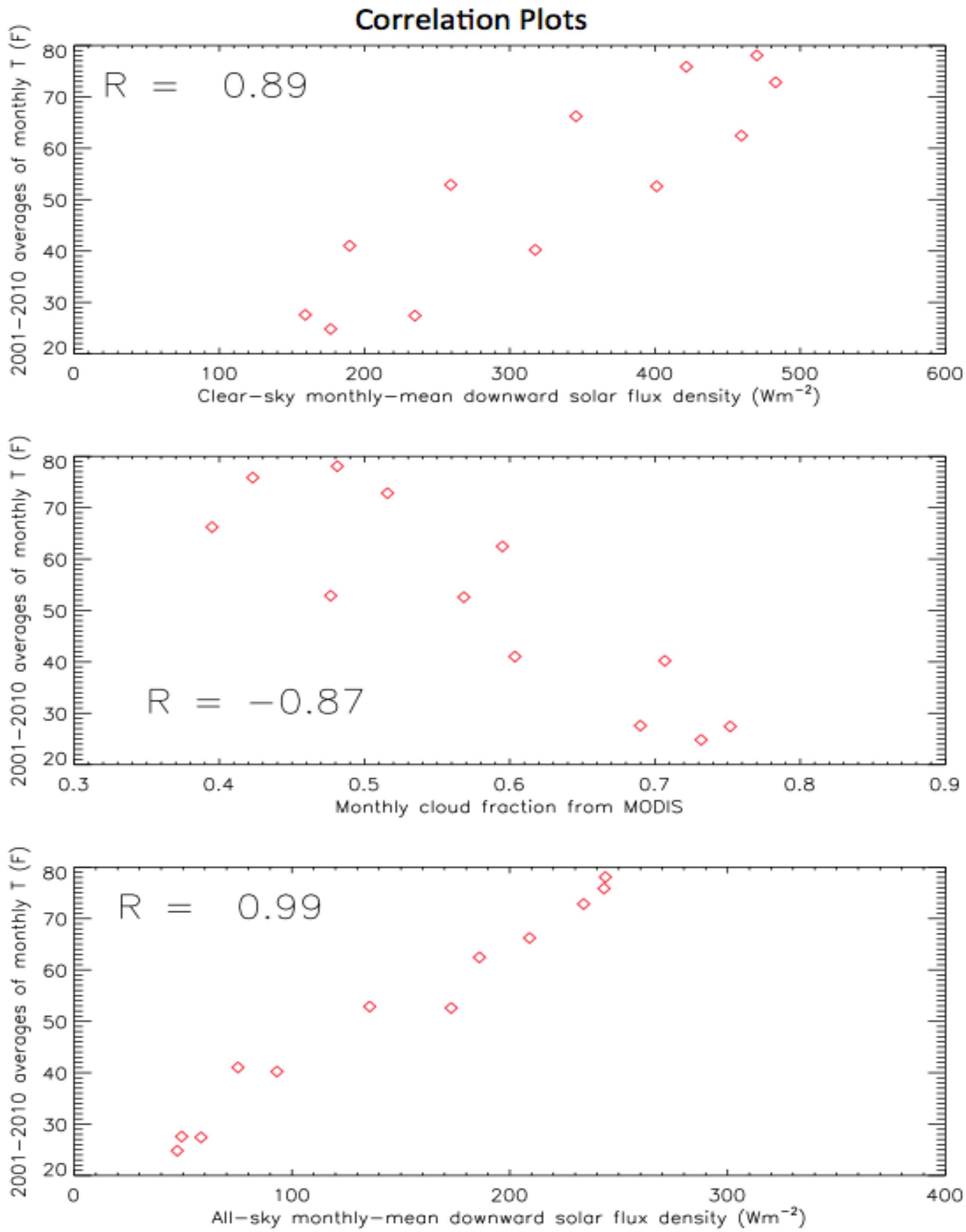


Figure 5. A plot of a student's homework showing the correlation of Lincoln's monthly mean temperature in 2001-2010 (y-axis) with (a) clear-sky monthly-mean downward solar flux; (b) monthly-mean cloud fraction, and (c) all sky monthly-mean downward flux. All sky monthly mean downward flux is product between clearly sky and cloud fraction. The figure clearly shows the Lincon's variation of monthly temperature can be better explained by considering cloud fraction.

Mid-term/Final Exam

The mid-term exam is held right before the Spring break, covering the lecture materials related to radiative transfer. The final exam is held in the final exam week, covering primarily the lecture materials related to cloud, precipitation, and lightning. The materials taught prior to mid-term exam only take up ~10% in the final exam. While the mid-term and final exam organically and respectively cover the two parts of the course, they are linked through the role of cloud in the atmospheric radiative transfer.

In the class one week before each exam, I provide ~40 minute review in the class to highlight the key topics taught in the class. I also layout the structure of the exam, and handout a 3-by-7 inch note card for students to write whatever they want and bring that note card during the exam. My philosophy for designing an exam is not to test the students' memory, but to evaluate the students' understanding of physical principals and concepts, as well as students' use of these principals and concepts to solve practical problems. Memorizing what being taught is not an effective way for student to learn; only those memories with a good understanding can last long.

With above thinking for designing the exam, the problems in the exam often include multiple options, true/false and why, figure interpretation, and quantitative problem solving. One example of linking theory to real phenomena is provided in Figure 6.

4. **Calculations**. Calculations can be made using calculator but the results, units, and steps should be shown clearly in a readable format on the paper.

1. Consider two clouds with the same liquid water content of(0.5 g m^{-3}), one composed of water droplets with a radius of 10 μm and the other with droplets with a radius of 1 mm. [3+5+4 points]

   (A) Estimate N, the number concentration per m^3.

   (B) Assuming that the scattering efficiency Q_e for visible radiation is the same for the two droplet sizes, compare the volume scattering coefficients Q_eNS, where S is the geometric cross sectional area of one droplet.

   (C) Based upon the answers in (A) and (B), explain the mechanisms for producing "ship tracks" as seen in the following satellite image.

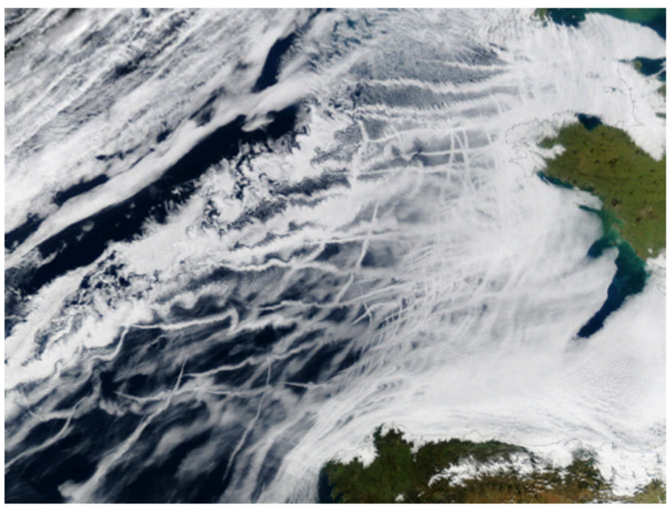


Figure 6. A problem in the final exam showcases the emphasis of linking the theory to the interpretation of real observations.

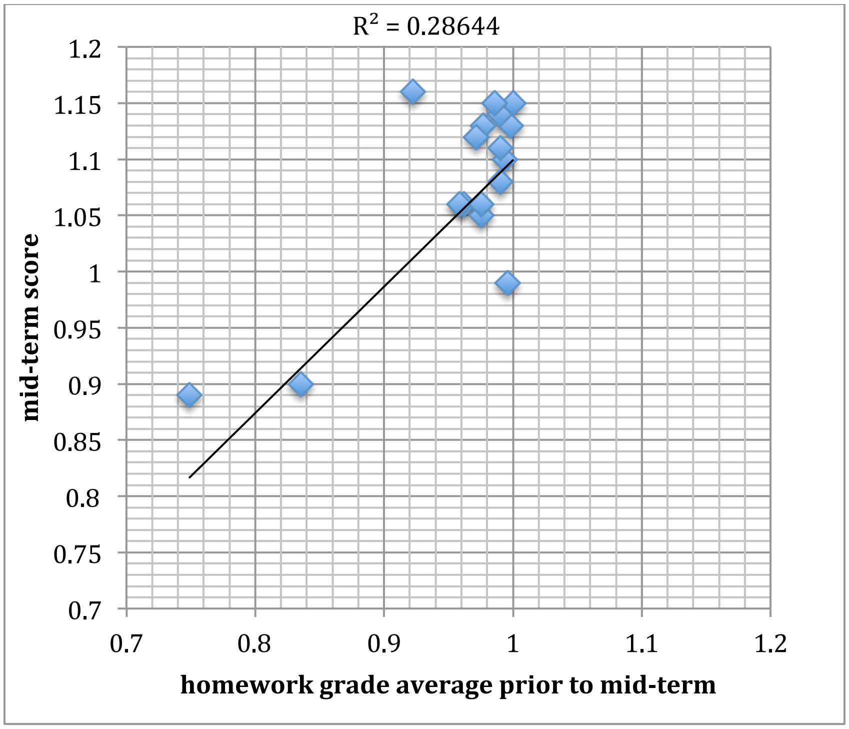
Assessment of Student Learning

Assessment of student learning is based upon the students' homework/lab assignment grade, mid-term and final exam grade, as well as the survey conducted in the class. Final grade of the course is a sum of homework grade (30%), mid-term exam grade (30%), and final exam (30%), with a full score of 100. Grade A is given if the overall score is 90 and more. See details about grading in Appendix A.

In Spring 2013, 18 students were enrolled in the class, including two graduate students. Only one student's final grade is B, the other students all received a grade of A. It is also noted that the class only had one female student, but the student who received B was not the female student.

Correlation analysis shows a moderate correlation (R^2=0.25) between homework average score and the exam score (Figure 7). This suggests that students should spend their efforts in learning regularly by doing homework and lab assignment in order to learn well throughout the semester.

Further analysis shows that, after the field hands-on activity is introduced, the majority of students (15 out of 18) had significant improvement in their exam grade (Figure 8). Further survey (Appendix B) shows that students were overall happy with learning through hands-on activity and through survey to reflect their recommendations to the instructor regarding the potential area for improving teaching.



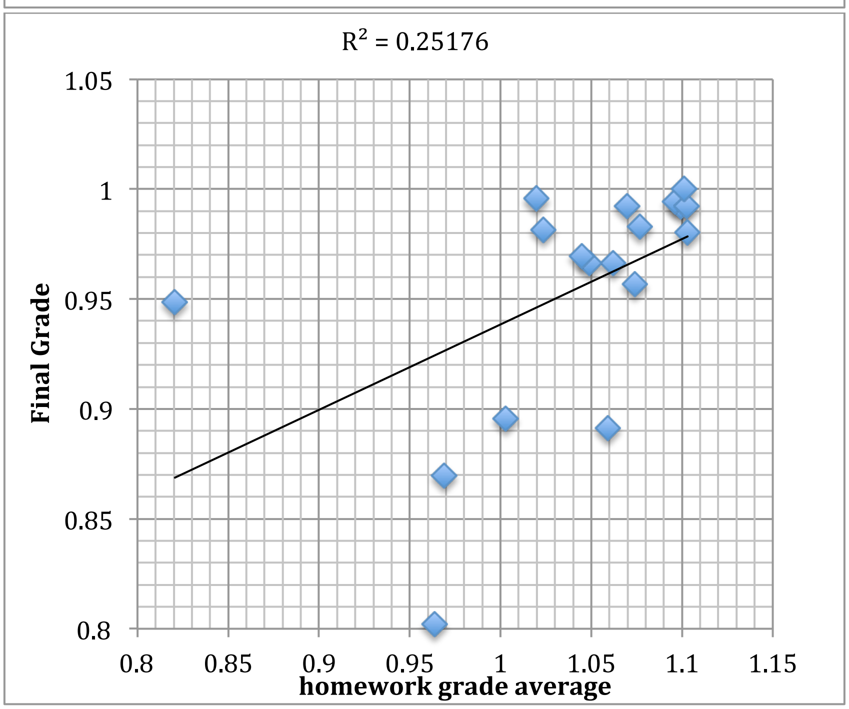


Figure 7. correlation analysis between homework grade average vs. exam grade for mid-term (top) and final (bottom).

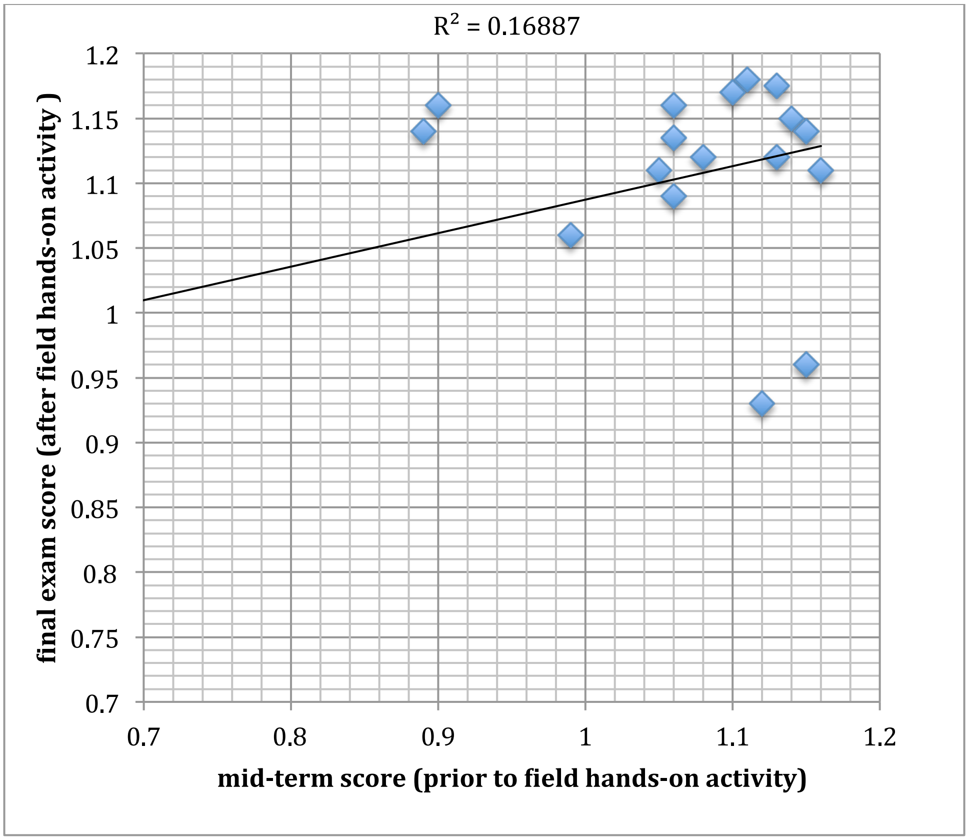


Figure 8. Scatter plot of mid-term score vs. final exam score. After the field hands-on activity was introduced, only 3 students that did not show any improvement in the final score (as compared to their mid-term exam score) all other 15 students showed apparent improvement (by average 5 points out of 100) in their final exam grade over their mid-term exam grade. Note, in both final and mid-term exams, the total points are 120, and the students'' score are scaled to 1.2 here for the purpose of plotting.

Appendix A: Syllabus

PHYSICAL METEOROLOGY

INSTRUCTOR: DR. JUN WANG
http://www.eas.unl.edu/~jwang

INSTRUCTOR'S CONTACT INFORMATION
Office: Bessey Hall, Room 303
Phone: 402-472-3597
Email: jwang7 at unl dot edu
Office hour: Tuesday 2:00-5:00 pm or by appointment; best through email contact

TA'S CONTACT INFORMATION
Amy Gehring
Email: agehring3@huskers.unl.edu

COURSE INFORMATION
Course #: METR 323/823
Prerequisites: CSCE 150E, METR 205, PHYS 212 (or Permission)
Class time: 9:30 - 10:45am, Tu. &Th.
Classroom: 104 Bessey Hall

COURSE DESCRIPTION
In this course we will investigate the physical processes that provide the foundation for weather forecasting and climate prediction, including radiative transfer, cloud and precipitation formation, as well as the atmospheric electricity. We will also explore the physical underpinnings of such atmospheric phenomena as optical displays (for example, rainbows, halos, etc.) and lightning. The primary software used for this class is IDL (Interactive Data Language).

REQUIRED TEXTBOOKS
A first course in atmospheric radiation (second edition), by G. W. Petty, Sundog publishing, ISBN: 0972903313, 2006.
A short course in cloud physics (third edition), by R. R. Rogers and M. K. Yau, Butterworth-Heinemann publishing, ISBN:0750632151, 1996.

OTHER TEXTBOOKS
An Introduction to Atmospheric Radiation (second Edition), by K. N. Liou, Academic Press, ISBN: 0124514510, 2002.
Atmospheric science – an introductory survey (section edition), by J. M. Wallace and P. V. Hobbs, Academic Press, ISBN: 012732951X, 2006.
Lighting – physics and effects, by V. A. Radkov and M. A. Uman, Cambridge University Press, ISBN: 0521035414, 2003.

Lab Assignments

Lab assignments are given regularly. Students should turn in their completed assignments by due date given in the assignment. The penalty for late return of assignments is 20% deduction per day on the grade of that assignment.

Expectations

The course has many hands-on projects that require computer programming and field work. Improving computer programming skills requires a daily grind of practice and determination. Students are expected to work hard and achieve the highest standards. Independent work is strongly encouraged. I also expect students to participate actively in class by asking and answering questions about the course material.

Graduate Credit

To earn graduate credit for this course, students will be expected to complete a term project in addition to the above requirements. The nature and topic of the project will be determined in consultation with the instructor.

Sick/Emergency Leave Policy

If you will miss an exam for medical or emergency reasons, you must contact the instructor or leave a message with the department secretary (402-472-2663) before the scheduled exam time. Makeup exams will be given only to those students who have contacted the instructor or the department secretary prior to the scheduled exam.

Other Business Policy

If you will miss the due date of an assignment because of business travel (e.g., attending AMS or other conferences), the due date of the assignment will be extended for a time period equivalent to the number of days you actually spent in the travel. In order to obtain this extension, you must inform your instructor about your travel time before the travel.

Grade Policy

Regular lab assignments: 30% of final grade;
One mid-term exam: 30% of final grade;
Final exam: 40% of final grade;
Grading scale: A ≥ 90%; 80% ≤ B < 90%; 70% ≤ C < 80%; 60% ≤ D < 70%; E < 60%

Final Note

If you have a documented learning disability and will be requesting academic accommodation for this class, please contact The Offices of Services for Students with Disabilities (http://www.unl.edu/ssd/).

CLASS SCHEDULE[1]

Week #	Date	Topics	Remarks
1	01/08	Introduction	GWP Ch1
	01/10		AMS meeting
2	01/15	Properties and description of Radiation	GWP Ch3&3
	01/17	Reflection and refraction	GWP Ch4
3	01/22	TBD	
	01/24	On travel	
4	01/29	Reflection and refraction	GWP Ch4
	01/31	Radiative properties of natural sufaces	GWP Ch5
5	02/05	Blackbody law and thermal emission	GWP Ch6
	02/07	Blackbody law and thermal emission	GWP Ch6
6	02/12	Gas absorption and particle scattering	GWP Ch9
	02/14	Gas absorption and particle scattering	GWP Ch7,11,12
7	02/19	Atmospheric optical phenomena	GWP Ch7, 8, 11
	02/21	Optical phenomena and radiative transfer	GWP Ch 7
8	02/26	Radiative transfer	GWP Ch 8
	03/28	Radiative transfer	GWP Ch 10
9	03/05	Radiative transfer, heating rate	GWP Ch 10
	03/07	Mid-term review	
10	03/12	Visiblity	
	03/14	Mid-term exam	
11	03/19		Spring break
	03/21		Spring break
12	03/26	Observed properties of clouds	RY Ch5
	03/28	Observed properties of clouds	RY Ch5
13	04/02	Formation of Cloud Droplets	RY Ch6
	04/04	Formation of warm rain	RY Ch7, 8
14	04/09	Formation of ice crystals	RY Ch9
	04/11	Ice Rain and Snow	RY Ch10
15	04/16	Precipitation Process & lightning	RY Ch 12
	04/18	Lightning	Hands-out
16	04/23	TBD	
	04/25	Review for final exam	
17		Final exam	

[1] The schedule is subject to change depending on progress of the class and other unpredictable factors. Lab assignments and hand-out materials will be given regularly.

Appendix B. Survey conducted in the class.

Instructor's Self-Study Survey

1. This course uses the portal devices for you to measure atmospheric parameters (such as optical depth and water vapor) that are important to radiative transfer. With your experience, do you consider that such hands-on out-door activities are valuable for you to understand the concepts and theory taught in the classroom? what are some other ideas you have to use such devices?

Hands-on experience is always useful in my opinion. A fascinating way to understand exactly how some of the meteorlogical data we use is collected. And seeing that the data we collect backs up concepts learned in class helps to understand the material.

2. Through a series of homeworks, this course offered you an opportunity to build a numerical model to estimate the downward solar radiative flux at any given time over any location of the Earth. Your learned how to write different modules and eventually put all modules into a decent-size IDL program. Do you think such assignment (via a series of small tasks) is useful for you to develop analytical and programming skills? What other comments you have regarding the programming assignment in this course?

IDL is a good, strong programming language to use for this course. I can't say that program well, but throughout this semester, I have definitely gained much knowledge in this area.

3. In the class, I also tried to use videos and real satellite data to illustrate the concepts and bring the bigger context to the classroom. As a whole, do you feel that you learned more effectively through these videos and real data than through traditional means (e.g., black-board drawing)?

Yes. Using real data to back up concepts is the best way to prove concepts, and to give one other example to learn.

4. I tried several examples (such as ship-track images and calculations, and other optical phenomenon) to integrate two parts of this course. What are other good ideas you can recommend for teaching such as a class that include both particle scattering, radiative transfer, and cloud microphysics?

Calculations are very helpful to understand the homework and exam questions. Example calculations in class are the best to understand these concepts.

Instructor's Self-Study Survey

1. This course uses the portal devices for you to measure atmospheric parameters (such as optical depth and water vapor) that are important to radiative transfer. With your experience, do you consider that such hands-on out-door activities are valuable for you to understand the concepts and theory taught in the classroom? what are some other ideas you have to use such devices?

Yes I think its valuable to help understand because we can get a real sense of what we are recording. We get to look at real time data and compare it to what we see.

2. Through a series of homeworks, this course offered you an opportunity to build a numerical model to estimate the downward solar radiative flux at any given time over any location of the Earth. Your learned how to write different modules and eventually put all modules into a decent-size IDL program. Do you think such assignment (via a series of small tasks) is useful for you to develop analytical and programming skills? What other comments you have regarding the programming assignment in this course?

Yes this is useful because it does help with programming skills. Also you get to actually create graphs to view the data easier.

3. In the class, I also tried to use videos and real satellite data to illustrate the concepts and bring the bigger context to the classroom. As a whole, do you feel that you learned more effectively through these videos and real data than through traditional means (e.g., black-board drawing)?

Yes because I think visualizing the material in a video or satellite helps me to understand what processes are taking place.

4. I tried several examples (such as ship-track images and calculations, and other optical phenomenon) to integrate two parts of this course. What are other good ideas you can recommend for teaching such as a class that include both particle scattering, radiative transfer, and cloud microphysics?

I think doing more in class activities as a group would help.

Instructor's Self-Study Survey

1. This course uses the portal devices for you to measure atmospheric parameters (such as optical depth and water vapor) that are important to radiative transfer. With your experience, do you consider that such hands-on out-door activities are valuable for you to understand the concepts and theory taught in the classroom? what are some other ideas you have to use such devices?

Yes. Just using the data more and analyzing it using things we learned in class.

2. Through a series of homeworks, this course offered you an opportunity to build a numerical model to estimate the downward solar radiative flux at any given time over any location of the Earth. Your learned how to write different modules and eventually put all modules into a decent-size IDL program. Do you think such assignment (via a series of small tasks) is useful for you to develop analytical and programming skills? What other comments you have regarding the programming assignment in this course?

Yes. If there were many unrelated programming assignments, people would forget what they learned week to week. When all assignments are related, it is easier to remembe things.

3. In the class, I also tried to use videos and real satellite data to illustrate the concepts and bring the bigger context to the classroom. As a whole, do you feel that you learned more effectively through these videos and real data than through traditional means (e.g., black-board drawing)?

Yes. I enjoy a combination of the two; showing a concept and then using a real world example to illustrate the concept.

4. I tried several examples (such as ship-track images and calculations, and other optical phenomenon) to integrate two parts of this course. What are other good ideas you can recommend for teaching such as a class that include both particle scattering, radiative transfer, and cloud microphysics?

The examples you used were great.

Instructor's Self-Study Survey

1. This course uses the portal devices for you to measure atmospheric parameters (such as optical depth and water vapor) that are important to radiative transfer. With your experience, do you consider that such hands-on out-door activities are valuable for you to understand the concepts and theory taught in the classroom? what are some other ideas you have to use such devices?

I don't know if I would say it really helped understand the concepts as we were just learning how to operate it. It was a good experience though.

2. Through a series of homeworks, this course offered you an opportunity to build a numerical model to estimate the downward solar radiative flux at any given time over any location of the Earth. Your learned how to write different modules and eventually put all modules into a decent-size IDL program. Do you think such assignment (via a series of small tasks) is useful for you to develop analytical and programming skills? What other comments you have regarding the programming assignment in this course?

The programming assignments were ok at the beginning of the course but by the end of the course they were more of a nuisance and I feel people just wanted to get them done rather than think about what we were learning.

3. In the class, I also tried to use videos and real satellite data to illustrate the concepts and bring the bigger context to the classroom. As a whole, do you feel that you learned more effectively through these videos and real data than through traditional means (e.g., black-board drawing)?

The videos were great tools to help bolster our understanding.
The real satellite data really didn't help me too much.

4. I tried several examples (such as ship-track images and calculations, and other optical phenomenon) to integrate two parts of this course. What are other good ideas you can recommend for teaching such as a class that include both particle scattering, radiative transfer, and cloud microphysics?

I can't really think of any practical means by which to teach these other than the way that was done in class.

Instructor's Self-Study Survey

1. This course uses the portal devices for you to measure atmospheric parameters (such as optical depth and water vapor) that are important to radiative transfer. With your experience, do you consider that such hands-on out-door activities are valuable for you to understand the concepts and theory taught in the classroom? what are some other ideas you have to use such devices?

Yes, it is nice to get out of the classroom and away from just text and hearing it being talked about to actually doing it and seeing what we learned be verified.

2. Through a series of homeworks, this course offered you an opportunity to build a numerical model to estimate the downward solar radiative flux at any given time over any location of the Earth. Your learned how to write different modules and eventually put all modules into a decent-size IDL program. Do you think such assignment (via a series of small tasks) is useful for you to develop analytical and programming skills? What other comments you have regarding the programming assignment in this course?

It helped my programming very much. However, I don't think I would have been able to do it as well if I didn't have METR 223 (Thermodynamics) first. Basically, I needed a lot of experience prior to this class to do it, but this class helped me excel even more. It was nice having a lot of time to do each assignment.

3. In the class, I also tried to use videos and real satellite data to illustrate the concepts and bring the bigger context to the classroom. As a whole, do you feel that you learned more effectively through these videos and real data than through traditional means (e.g., black-board drawing)?

Yes, I wish there were more of them. Staring at equations loses my interest eventually.

4. I tried several examples (such as ship-track images and calculations, and other optical phenomenon) to integrate two parts of this course. What are other good ideas you can recommend for teaching such as a class that include both particle scattering, radiative transfer, and cloud microphysics?

Looped satellite images, and then explaining what is happening as it plays, verifying what we talk about in class.

Instructor's Self-Study Survey

1. This course uses the portal devices for you to measure atmospheric parameters (such as optical depth and water vapor) that are important to radiative transfer. With your experience, do you consider that such hands-on out-door activities are valuable for you to understand the concepts and theory taught in the classroom? what are some other ideas you have to use such devices?

Yes, they helped me to better understand how radiation works and how it is measured in the real world.

2. Through a series of homeworks, this course offered you an opportunity to build a numerical model to estimate the downward solar radiative flux at any given time over any location of the Earth. Your learned how to write different modules and eventually put all modules into a decent-size IDL program. Do you think such assignment (via a series of small tasks) is useful for you to develop analytical and programming skills? What other comments you have regarding the programming assignment in this course?

If I was better at programming then this might apply, but seeing the graphs we made helped me understand radiative transfer and solar flux at different times. If I knew IDL better, like the syntax of it, then the programming assignments may not have been as difficult for me. The thermo class before this doesn't teach much syntax, so it barely helped me out here.

3. In the class, I also tried to use videos and real satellite data to illustrate the concepts and bring the bigger context to the classroom. As a whole, do you feel that you learned more effectively through these videos and real data than through traditional means (e.g., black-board drawing)?

Yes. Seeing real data in real time gives me a better understanding of real world processes than some drawing.

4. I tried several examples (such as ship-track images and calculations, and other optical phenomenon) to integrate two parts of this course. What are other good ideas you can recommend for teaching such as a class that include both particle scattering, radiative transfer, and cloud microphysics?

Instructor's Self-Study Survey

1. This course uses the portal devices for you to measure atmospheric parameters (such as optical depth and water vapor) that are important to radiative transfer. With your experience, do you consider that such hands-on out-door activities are valuable for you to understand the concepts and theory taught in the classroom? what are some other ideas you have to use such devices?

While they don't help me understand the theory behind it, they definitely make it more interesting in application. So I would say that are very valuable.

2. Through a series of homeworks, this course offered you an opportunity to build a numerical model to estimate the downward solar radiative flux at any given time over any location of the Earth. Your learned how to write different modules and eventually put all modules into a decent-size IDL program. Do you think such assignment (via a series of small tasks) is useful for you to develop analytical and programming skills? What other comments you have regarding the programming assignment in this course?

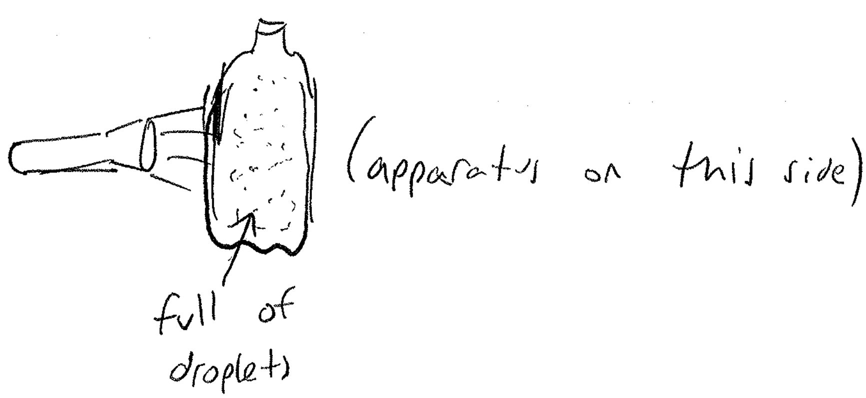
Yes! This was by far the best labwork I've done (from an interesting point of view). I like the idea of starting small and working up in complexity. I'd go as far to say we should have more lab assignments just to make it even more complex.

3. In the class, I also tried to use videos and real satellite data to illustrate the concepts and bring the bigger context to the classroom. As a whole, do you feel that you learned more effectively through these videos and real data than through traditional means (e.g., black-board drawing)?

Absolutely. It's good to see real data and results instead of speculation.

4. I tried several examples (such as ship-track images and calculations, and other optical phenomenon) to integrate two parts of this course. What are other good ideas you can recommend for teaching such as a class that include both particle scattering, radiative transfer, and cloud microphysics?

Perhaps use a plastic bottle full of condensate to measure scattering by having a flash light shine through it?



Instructor's Self-Study Survey

1. This course uses the portal devices for you to measure atmospheric parameters (such as optical depth and water vapor) that are important to radiative transfer. With your experience, do you consider that such hands-on out-door activities are valuable for you to understand the concepts and theory taught in the classroom? what are some other ideas you have to use such devices?

I don't think that the measurements helped ~~me~~ me to better understand the concepts. However, it was great to see that the measurements validated what we learned in class and predictably followed what we expected to happen. As far as other ideas are concerned, I really don't have any. I just wish that the weather would have been nicer so we could have gone outside more often to take measurements.

2. Through a series of homeworks, this course offered you an opportunity to build a numerical model to estimate the downward solar radiative flux at any given time over any location of the Earth. Your learned how to write different modules and eventually put all modules into a decent-size IDL program. Do you think such assignment (via a series of small tasks) is useful for you to develop analytical and programming skills? What other comments you have regarding the programming assignment in this course?

Yes, the programs were absolutely helpful in developing my analytical and programming skills. I really liked how we built on top of previous programs and created our own radiative transfer model step by step. I think this should definitely continue to be a part of the course in the future. I actually have grown to enjoy (to a certain extent) the programming.

3. In the class, I also tried to use videos and real satellite data to illustrate the concepts and bring the bigger context to the classroom. As a whole, do you feel that you learned more effectively through these videos and real data than through traditional means (e.g., black-board drawing)?

I liked how we looked at real data and graphical output from Satellites. I think that our class room discussion of the graphs really helped me ~~to~~ learn the material through Critical thinking. I certainly would continue to value this method of teaching perhaps even at the expense of the traditional teaching methods.

4. I tried several examples (such as ship-track images and calculations, and other optical phenomenon) to integrate two parts of this course. What are other good ideas you can recommend for teaching such as a class that include both particle scattering, radiative transfer, and cloud microphysics?

I think that homework problems and examples that require us to first do cloud microphysics and then use that information to calculate things like particle scattering and radiative transfer on problems late in the Semester would be very helpful to tie the material in the course together.

Instructor's Self-Study Survey

1. This course uses the portal devices for you to measure atmospheric parameters (such as optical depth and water vapor) that are important to radiative transfer. With your experience, do you consider that such hands-on out-door activities are valuable for you to understand the concepts and theory taught in the classroom? what are some other ideas you have to use such devices?

I believe it is very important to have many hands-on out-door activities. It reinforces concepts that were addressed in lecture. Personally, I am not a big fan of lecturing every class period. I want to be able to apply the concepts to real situations.

I think it would be cool if we could apply any of the measuring techniques to nighttime activities, such as measuring the moon's intensity.

2. Through a series of homeworks, this course offered you an opportunity to build a numerical model to estimate the downward solar radiative flux at any given time over any location of the Earth. Your learned how to write different modules and eventually put all modules into a decent-size IDL program. Do you think such assignment (via a series of small tasks) is useful for you to develop analytical and programming skills? What other comments you have regarding the programming assignment in this course?

Personally, I am not a fan of programming. Assignment 4 was extremely long, and I found programming to be more frustrating than useful for my learning. I never understood the purpose of programming. I would rather analyze graphs instead of making them on IDL.

3. In the class, I also tried to use videos and real satellite data to illustrate the concepts and bring the bigger context to the classroom. As a whole, do you feel that you learned more effectively through these videos and real data than through traditional means (e.g., black-board drawing)?

Videos are a great source of learning. It shifts the students' attention from listening to the professor. A recent study has shown that the average attention span of a student is 12 minutes, so a professor should change things up around every 12 minutes so that they don't waste the students time.

4. I tried several examples (such as ship-track images and calculations, and other optical phenomenon) to integrate two parts of this course. What are other good ideas you can recommend for teaching such as a class that include both particle scattering, radiative transfer, and cloud microphysics?

I would like to see the professor do some IDL programming in class. Maybe if the professor could write very small programs for some of the calculations, then the students would understand IDL better.

Also, I would like the professor to go over the homework assignments since we did not go over them in lab. It would help reinforce my learning.

Instructor's Self-Study Survey

1. This course uses the portal devices for you to measure atmospheric parameters (such as optical depth and water vapor) that are important to radiative transfer. With your experience, do you consider that such hands-on out-door activities are valuable for you to understand the concepts and theory taught in the classroom? what are some other ideas you have to use such devices?

Yes, it shows real world hands on applications for concepts discussed in class. It also provides an exciting/fun way to get extra practice with thing learned in lecture besides just in class problems.

2. Through a series of homeworks, this course offered you an opportunity to build a numerical model to estimate the downward solar radiative flux at any given time over any location of the Earth. Your learned how to write different modules and eventually put all modules into a decent-size IDL program. Do you think such assignment (via a series of small tasks) is useful for you to develop analytical and programming skills? What other comments you have regarding the programming assignment in this course?

Breaking the program up into smaller homeworks definetly helped to slowly build the model. I think any numerical modeling program practice is especially important as modern meteorology is rapidly requiring more and more of this

3. In the class, I also tried to use videos and real satellite data to illustrate the concepts and bring the bigger context to the classroom. As a whole, do you feel that you learned more effectively through these videos and real data than through traditional means (e.g., black-board drawing)?

I am more of a visual learner so the more visualizations I can see, the more I learn about a concept so yes the videos did help. It is also good to make connections to real life examples.

4. I tried several examples (such as ship-track images and calculations, and other optical phenomenon) to integrate two parts of this course. What are other good ideas you can recommend for teaching such as a class that include both particle scattering, radiative transfer, and cloud microphysics?

Once again, I am a visual learner so these examples helped my understanding greatly. I thought breaking the class up into the two sections worked well.

Instructor's Self-Study Survey

1. This course uses the portal devices for you to measure atmospheric parameters (such as optical depth and water vapor) that are important to radiative transfer. With your experience, do you consider that such hands-on out-door activities are valuable for you to understand the concepts and theory taught in the classroom? what are some other ideas you have to use such devices?

For me the outdoor activities are helpful, but I notice when we are in large groups outside only a handful of students are actually engaged. I recommend continuing the outdoor projects just in smaller groups.

2. Through a series of homeworks, this course offered you an opportunity to build a numerical model to estimate the downward solar radiative flux at any given time over any location of the Earth. Your learned how to write different modules and eventually put all modules into a decent-size IDL program. Do you think such assignment (via a series of small tasks) is useful for you to develop analytical and programming skills? What other comments you have regarding the programming assignment in this course?

Yes building up to one final assignment is a much easier way to understand the programming language.

The pace of the progamming and assignments is perfect don't change it.

3. In the class, I also tried to use videos and real satellite data to illustrate the concepts and bring the bigger context to the classroom. As a whole, do you feel that you learned more effectively through these videos and real data than through traditional means (e.g., black-board drawing)?

yes videos are always helpful. The videos are able to illustrate what you are trying to get across to us from the lecture. I recommend more videos if possible

4. I tried several examples (such as ship-track images and calculations, and other optical phenomenon) to integrate two parts of this course. What are other good ideas you can recommend for teaching such as a class that include both particle scattering, radiative transfer, and cloud microphysics?

Actually have a prism to show diffusion of light.

Instructor's Self-Study Survey

1. This course uses the portal devices for you to measure atmospheric parameters (such as optical depth and water vapor) that are important to radiative transfer. With your experience, do you consider that such hands-on out-door activities are valuable for you to understand the concepts and theory taught in the classroom? what are some other ideas you have to use such devices?

Yes, they were very valuable. I think we could've used them more or analyze the results more.

2. Through a series of homeworks, this course offered you an opportunity to build a numerical model to estimate the downward solar radiative flux at any given time over any location of the Earth. Your learned how to write different modules and eventually put all modules into a decent-size IDL program. Do you think such assignment (via a series of small tasks) is useful for you to develop analytical and programming skills? What other comments you have regarding the programming assignment in this course?

The programming wasn't focused on combining modules very well. Often, we ended up rewriting sections of code that could've been eliminated with a function/procedure.

Overall the programming was useful, though.

3. In the class, I also tried to use videos and real satellite data to illustrate the concepts and bring the bigger context to the classroom. As a whole, do you feel that you learned more effectively through these videos and real data than through traditional means (e.g., black-board drawing)?

Yes, but there weren't very many videos.

4. I tried several examples (such as ship-track images and calculations, and other optical phenomenon) to integrate two parts of this course. What are other good ideas you can recommend for teaching such as a class that include both particle scattering, radiative transfer, and cloud microphysics?

I think those topics are good, along with using the cloud fraction in the fourth homework assignment.

Instructor's Self-Study Survey

1. This course uses the portal devices for you to measure atmospheric parameters (such as optical depth and water vapor) that are important to radiative transfer. With your experience, do you consider that such hands-on out-door activities are valuable for you to understand the concepts and theory taught in the classroom? what are some other ideas you have to use such devices? Yes, very valuable. Becoming experienced with atmospheric measuring devices is important.

2. Through a series of homeworks, this course offered you an opportunity to build a numerical model to estimate the downward solar radiative flux at any given time over any location of the Earth. Your learned how to write different modules and eventually put all modules into a decent-size IDL program. Do you think such assignment (via a series of small tasks) is useful for you to develop analytical and programming skills? What other comments you have regarding the programming assignment in this course?

Yes it was useful. Regarding that last assignment it felt like we were building on previous assignments but then we made a big jump with reading in files. Seemed like there were a lot of steps to complete for the one assignment.

3. In the class, I also tried to use videos and real satellite data to illustrate the concepts and bring the bigger context to the classroom. As a whole, do you feel that you learned more effectively through these videos and real data than through traditional means (e.g., black-board drawing)?

Yes, the freezing water bottle video helped substantially.

4. I tried several examples (such as ship-track images and calculations, and other optical phenomenon) to integrate two parts of this course. What are other good ideas you can recommend for teaching such as a class that include both particle scattering, radiative transfer, and cloud microphysics?

No comment. I thought the class was taught very effectively.

3. In the class, I also tried to use videos and real satellite data to illustrate the concepts and bring the bigger context to the classroom. As a whole, do you feel that you learned more effectively through these videos and real data than through traditional means (e.g., black-board drawing)?

The videos are examples worked out in class were very useful and helped my learning.

4. I tried several examples (such as ship-track images and calculations, and other optical phenomenon) to integrate two parts of this course. What are other good ideas you can recommend for teaching such as a class that include both particle scattering, radiative transfer, and cloud microphysics?

All examples used in the class were excellent.

Instructor's Self-Study Survey

1. This course uses the portal devices for you to measure atmospheric parameters (such as optical depth and water vapor) that are important to radiative transfer. With your experience, do you consider that such hands-on out-door activities are valuable for you to understand the concepts and theory taught in the classroom? what are some other ideas you have to use such devices?

   I enjoyed using the portal devices and felt they helped me understand the concepts better.

2. Through a series of homeworks, this course offered you an opportunity to build a numerical model to estimate the downward solar radiative flux at any given time over any location of the Earth. Your learned how to write different modules and eventually put all modules into a decent-size IDL program. Do you think such assignment (via a series of small tasks) is useful for you to develop analytical and programming skills? What other comments you have regarding the programming assignment in this course?

   I feel this class helped me immensely in my programming skills of which I expect to be able to use for years to come. I think the programming assignments were a great way to practice, thus very useful.

Instructor's Self-Study Survey

1. This course uses the portal devices for you to measure atmospheric parameters (such as optical depth and water vapor) that are important to radiative transfer. With your experience, do you consider that such hands-on out-door activities are valuable for you to understand the concepts and theory taught in the classroom? what are some other ideas you have to use such devices?

Yes, the outdoor activity should be increase, and the [illegible] is important to reduce to the student.

2. Through a series of homeworks, this course offered you an opportunity to build a numerical model to estimate the downward solar radiative flux at any given time over any location of the Earth. Your learned how to write different modules and eventually put all modules into a decent-size IDL program. Do you think such assignment (via a series of small tasks) is useful for you to develop analytical and programming skills? What other comments you have regarding the programming assignment in this course?

Yes, the program is very useful to anaylis not only physical & conceptually. It should increase a mount of programing in IDL to let studet to get used to it!

3. In the class, I also tried to use videos and real satellite data to illustrate the concepts and bring the bigger context to the classroom. As a whole, do you feel that you learned more effectively through these videos and real data than through traditional means (e.g., black-board drawing)?

Yes

video explain more than tradition drawing

also explain as picture change help

leaning faster

4. I tried several examples (such as ship-track images and calculations, and other optical phenomenon) to integrate two parts of this course. What are other good ideas you can recommend for teaching such as a class that include both particle scattering, radiative transfer, and cloud microphysics?

The video, or the ~~[illegible]~~ personal image

to show to the student will be great

Instructor's Self-Study Survey

1. This course uses the portal devices for you to measure atmospheric parameters (such as optical depth and water vapor) that are important to radiative transfer. With your experience, do you consider that such hands-on out-door activities are valuable for you to understand the concepts and theory taught in the classroom? what are some other ideas you have to use such devices?

I believe these outdoor activities are beneficial, they provide a good connect b/w theory & real world physical phenomena. Global, direct & diffused radiation can be measured on different surfaces to measure albedo effects.

2. Through a series of homeworks, this course offered you an opportunity to build a numerical model to estimate the downward solar radiative flux at any given time over any location of the Earth. Your learned how to write different modules and eventually put all modules into a decent-size IDL program. Do you think such assignment (via a series of small tasks) is useful for you to develop analytical and programming skills? What other comments you have regarding the programming assignment in this course?

Using IDL to program was very useful. It bettered my programming skills, helped me learn about new functions and made my coding more efficient.

3. In the class, I also tried to use videos and real satellite data to illustrate the concepts and bring the bigger context to the classroom. As a whole, do you feel that you learned more effectively through these videos and real data than through traditional means (e.g., black-board drawing)?

Using videos & real satellite data was undoubtedly more effective than traditional means. they were more interactive and were also updated.

4. I tried several examples (such as ship-track images and calculations, and other optical phenomenon) to integrate two parts of this course. What are other good ideas you can recommend for teaching such as a class that include both particle scattering, radiative transfer, and cloud microphysics?

More satellite data could be used to show radiative transfer phenomena's relations to the cloud types.

Instructor's Self-Study Survey

1. This course uses the portal devices for you to measure atmospheric parameters (such as optical depth and water vapor) that are important to radiative transfer. With your experience, do you consider that such hands-on out-door activities are valuable for you to understand the concepts and theory taught in the classroom? what are some other ideas you have to use such devices?

I think the hands-on out door activities were very valuable. They let students see why exactly they are learning certain concepts in the classroom. Possibly a paper over the measurements -

2. Through a series of homeworks, this course offered you an opportunity to build a numerical model to estimate the downward solar radiative flux at any given time over any location of the Earth. Your learned how to write different modules and eventually put all modules into a decent-size IDL program. Do you think such assignment (via a series of small tasks) is useful for you to develop analytical and programming skills? What other comments you have regarding the programming assignment in this course?

Yes I think the assignment was very useful to develop analytical & programming skills. The programming teaches students how to solve a problem & also what the data they have can tell them about whats going on in the atmosphere. The programming lets students get good hands-on experience w/ real atmospheric data, and how to interpret this data.

3. In the class, I also tried to use videos and real satellite data to illustrate the concepts and bring the bigger context to the classroom. As a whole, do you feel that you learned more effectively through these videos and real data than through traditional means (e.g., black-board drawing)?

Yes, it really helped me learn much - The visual aids keeps learning fun & interesting.

4. I tried several examples (such as ship-track images and calculations, and other optical phenomenon) to integrate two parts of this course. What are other good ideas you can recommend for teaching such as a class that include both particle scattering, radiative transfer, and cloud microphysics?

Studying clouds from above combined with microphysical variables possibly ~~retrieved~~ from radar or some hydrometeor classification.